

ITEM L-111 AIRFIELD LIGHTING SYSTEM TESTING

DESCRIPTION

111-1.1 This item shall consist of furnishing all equipment, materials and appliances necessary for testing of airfield lighting circuit installations and associated systems. Airfield lighting systems include airfield signage systems.

a. The Contractor shall provide all testing as required by this item, including retesting of failed items. The Contractor shall provide all electrical testing to confirm that lighting system installations associated with this project are acceptable. The Owner shall engage an independent agency to perform the repairs. Specified photometric testing, with the Contractor providing all testing support and assistance, shall be made at the Contractor's expense.

b. Requirements under this item shall be coordinated with the Engineer.

c. This section describes the testing and demonstrations furnished by this Contractor. All items furnished and/or installed by this Contractor shall be tested and demonstrated in accordance with these specifications. All equipment and labor required for testing and demonstrations shall be furnished by this Contractor.

d. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components. The Engineer shall be notified by the Contractor forty-eight (48) hours in advance of any testing.

EQUIPMENT AND MATERIALS

111-2.1 GENERAL. Materials and equipment covered by this item shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer. All equipment, materials, methods and record keeping procedures shall be submitted to the RPR for review.

111-2.2 TEST EQUIPMENT. All test equipment proposed for use shall have a current calibration. Calibration certifications are current for 1 year from date of calibration. At any time, the Engineer may require the Contractor to have a piece of test equipment recalibrated. The test equipment will be removed from the project until recalibrated. The Contractor shall submit the Calibration labs qualifications and the test equipments serial numbers and calibration certificates to the Engineer for review.

CONSTRUCTION METHODS

111-3.1 GENERAL. The Contractor shall furnish all necessary equipment and appliances for testing installations as indicated below.

111-3.2 GROUND ROD TESTING.

a. Contractor shall provide equipment and personnel to measure the resistance to earth for all ground rods installed using Fall of Potential Method. Earth resistance measurement tests shall adhere to recommendations of IEEE Standard 142, latest edition. Contractor shall submit testing procedure and equipment and report form to the RPR for approval.

b. Tests shall be administered as each rod is installed. Tests shall be conducted prior to the connection of any grounding or counterpoise conductors. The resistance between each ground rod and

absolute earth shall not exceed twenty-five (25) ohms. Any rod, which does not have a resistance to ground of 40 25 ohms or less, shall be augmented by an additional 10' section of rod until the 10 ohm maximum earth resistance requirement is met. Test results shall be submitted to the RPR for approval.

111-3.3 AIRFIELD LIGHTING CIRCUITS TESTING. The Contractor shall notify the Engineer 72 hours prior to cable testing. All testing shall be conducted in the presence of the Engineer. All test results shall be simultaneously recorded by the Contractor and RPR. Contractor shall submit test report information to the Engineer. Test procedures for the following required tests, including field test report forms, shall be submitted to the Engineer for review prior to testing.

a. Testing Requirements:

(1) Testing Required for Existing Circuits and Existing Portions of Circuits to be Extended. The existing circuits to be extended shall be subjected to Low Voltage Tests in accordance with paragraph b.(1) below. Tests shall be performed with the isolation transformers and other lighting system devices connected. Test results shall be submitted to the Engineer for approval prior to extending or revising the existing circuit.

(2) Testing Required for Existing Circuits with Circuit Modifications and/or Extensions Completed. Each existing series circuit that has been modified and /or extended shall be subjected to Low Voltage Tests in accordance with paragraph b.(1) below. Tests shall be performed with the lighting isolation transformers and other lighting system devices connected. Circuits tested shall meet the requirements of paragraph c.(2) below. Any faults indicated by these tests shall be corrected before proceeding with additional testing. Test results shall be submitted to the Engineer for approval.

(3) Testing Required For New Circuits and New Portions of Existing Circuits. Each new series circuit, or new segment of existing circuits being extended, modified, or replaced, shall be tested as follows:

(a) After new cable with new connectors is installed and prior to connecting isolation transformers, the following tests shall be performed:

(i) Low Voltage Continuity and Insulation Resistance (IR) Tests in accordance with paragraph b.(1) below to determine if the total insulation resistance of each circuit is satisfactory so that the series lighting circuit will operate without excessive leakage current when energized. Circuits tested shall meet the requirements of paragraph c.(3)(a) below. Any faults indicated by these tests shall be corrected before proceeding with additional testing. All test results shall be submitted to the Engineer for approval.

(b) New segments of existing circuits meeting the requirements of paragraph a.(3)(a) above shall then have the isolation transformers connected and shall again be subjected to the Low Voltage Continuity and Insulation Resistance (IR) Tests of paragraph b.(1). Any faults indicated by these tests shall be corrected before energizing the circuit. All test results shall be submitted to the Engineer for approval.

(4) All Circuits. Upon completion of all wiring of each circuit, the Low Voltage Continuity and Insulation Resistance (IR) Tests shall be performed on the completed circuit in accordance with paragraph b.(1) below. All isolation transformers and other lighting system devices shall be connected to the completed circuit. Circuits tested shall meet the requirements of paragraph c.(3)(a) below. Any faults indicated by these tests shall be corrected before proceeding with additional testing. All test results shall be submitted to the Engineer for approval.

b. Testing Procedures:**(1) Low Voltage Tests. Low Voltage Continuity and Insulation-Resistance (IR) Tests**

(a) Test Required. As noted in paragraph a. above, circuits and segments of circuits shall be subjected to a low voltage continuity test and to a 2,500 volt Insulation-Resistance (IR) (Megger) test. IR tests shall test the insulation resistance to ground and other conductors within the same raceway of each lighting system conductor.

(b) Test Equipment. Contractor shall provide a 2,500 volt direct current Insulation Resistance test set for low voltage testing. Insulation Resistance test set shall be a 120V AC device, non-crank type, as manufactured by Associated Research Meg-Check, the James Biddle Megger, General Radio Megohmmeter, or approved equivalent. The Contractor shall be responsible for providing any required 120V AC power source at testing locations remote from available power. Equipment calibration information shall be readily available for review by the Engineer if requested.

(c) Test Procedures. "Lock-Tag-Try Procedure" requirements established by shall be comply with OSHA 1926.417. Test procedures for the required tests, including field test report forms, shall be submitted to the Engineer for approval prior to testing.

(i) Test equipment grounding electrode shall be adjacent to the test equipment and be a part of/connected to the airfield grounding counterpoise/ground rod system.

(ii) Verify that all devices and accessories connected to the cable are rated for the test voltage to be applied.

(iii) Ground other cables in the same conduit as cable under test.

(iv) Clean and isolate "remote" end of cable to be tested.

(v) Ground the cable for a minimum of one (1) minute prior to testing.

(vi) Test cable.

(vii) After testing is complete, cable shall be discharged to the grounding electrode using resistor designed for the purpose. Solidly ground the cable after discharge. Cable shall remain solidly grounded for a minimum of 5 minutes.

(d) Test Results. Cable specimens that do not meet the test criteria given in paragraphs c. (2) for existing circuits that have been modified and/or extended, and c. (3), for new circuits and new segments of existing circuits, shall be considered unacceptable. Refer to paragraph d. below for cables not meeting testing requirements.

(2) For all Testing. All existing and/or new cables, equipment, and materials damaged during testing shall be repaired and/or replaced by the Contractor at no additional cost to the Owner as directed by the RPR. Tests shall be performed and faulty installations corrected until satisfactory results are obtained. Exact correction procedures for specific faulty installation circumstances shall be as specified and approved by the RPR. The Contractor is not responsible for the repair of existing cables that are to be modified or extended that are deemed by the RPR to be faulty prior to modification or extension unless directed by the Contract Documents.

c. Testing Results:

(1) Existing Circuits and Existing Portions of Circuits to be Extended or Modified. Low voltage continuity test results and insulation resistance test results shall be submitted to the RPR for determination of suitability for extension or modification and any remedial action that may be appropriate.

(2) Existing Circuits and Existing Portions of Circuits that have been Extended or Modified. Low Voltage Tests shall demonstrate to the satisfaction of the RPR the following:

(a) All circuits are properly connected in accordance with the applicable wiring diagrams.

(b) All lighting power and control circuits are continuous and free from short circuits.

(c) All circuits are free from unspecified grounds.

(d) The insulation-resistance is equal to or greater than its original value prior to circuit modifications.

(3) New Circuits and New Segments of Existing Circuits.

(a) Low Voltage Tests shall demonstrate to the satisfaction of the RPR the following:

(i) All circuits are properly connected in accordance with the applicable wiring diagrams.

(ii) All lighting power and control circuits are continuous and free from short circuits.

(iii) All circuits are free from unspecified grounds.

(iv) The insulation-resistance is equal to or greater than 400 megohms for new circuits and new segments of existing circuits. Isolation transformers shall be connected. In addition, new circuits and new segments of existing circuits shall maintain an insulation resistance of not less than 300 megohms, with isolation transformers connected, through the end of the construction warranty period.

(v) Insulation-resistance of cables of approximately the same length installed in same duct bank shall not show a comparison ratio of over 3 to 1.

d. Deficient Testing Results (Circuits Not Meeting Requirements):

(1) Existing Circuits and Existing Portions of Circuits that have been Extended or Modified.

(2) Cables that do not meet the test criteria of paragraph c.(2) above shall be considered unacceptable and shall not be energized until corrected.

(3) If all "Lock-Tag-Try Procedure" requirements established **OSHA 1926.417** have been satisfied by the Contractor and the RPR determines non-complying circuits or segments of circuits

are the responsibility of the Owner, then the Contractor shall provide to the Owner, through the RPR, all test reports identifying location of non-complying cables.

(4) New Circuits and New Portions of Existing Circuits. Cables that do not meet the test criteria of subparagraph c(3) above shall be considered unacceptable and shall not be energized until corrected.

e. Submittal of Testing Data:

(1) Low Voltage Tests. Contractor shall submit twelve (12) copies of tests reports for approval of the RPR. Report shall include all measured data including applied voltage, time length of voltage application and measured megohms from each segment of cable in a circuit.

The Low Voltage Tests data form shall also include, as a minimum:

Date
Cable Number
Start Time
End Time
Operating Voltage
Max. Test Voltage
Cable Routing
Cable Description
Ambient Temperature
Humidity
Relative Humidity
Measure Equip. No.
Equipment Calibration Due Date

111-3.4 SYSTEM TESTS. After the airfield lighting systems installation is complete and at such times as the RPR may direct, the contractor shall conduct airfield lighting systems operating tests for approval.

a. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the RPR. The Contractor shall furnish all equipment and personnel required for the test.

b. Each applicable control device in the control tower lighting panels shall be operated so that each control device position is engaged at least ten times. During this process, all lights and associated equipment shall be observed to determine that each control device switch properly commands the corresponding circuit. Radio communication between the operator and the observers shall be provided by the Contractor.

c. The above tests shall be repeated for each individual circuit from the local control switches on the regulators. Each installed or revised lighting circuit shall be tested by operating the lamps throughout the range of applicable steps and shall be operated separately at step 3 or step 5 as appropriate for full intensity for not less than 8 hours. Visual examination shall be made at the beginning and at the end of this test to determine that the installed airfield light fixtures are illuminating at full intensity.

d. If circuit regulators are installed under project construction, regulator output ampacity shall be adjusted for proper outputs in accordance with manufacturer's recommendations and requirements to insure proper circuit operation.

e. Systems tests shall confirm by demonstration in service that all lighting circuits are in good operating condition to the satisfaction of the RPR. If the tests are unsatisfactory, lighting systems installed shall be corrected and systems tests shall again be implemented.

111-3.5 PHOTOMETRIC TESTING.

a. General. The Contractor shall retain an airfield lighting and signage photometric testing firm to perform photometric testing of all fixtures and signs installed in this contract. Electrical and photometric testing of airfield lighting systems shall be performed by a firm with demonstrated capability for field measurement of electrical characteristics of airfield lighting circuits and regulators and of the photometric performance of airfield lighting fixtures. Because of the correlation between the electrical performance of airfield lighting circuits and the photometric performance of the airfield lighting fixtures, all work shall be done by a single firm. The firm shall have experience in evaluating the test results against FAA standards and manufacturers' performance criteria. The firm shall demonstrate its capability by having performed similar work successfully at no less than five (5) international air carrier airports. The firm shall be subject to the RPR's approval. Two possible firms are listed below:

Lean Photometrics LLC
10316 North 49th Place
Scottsdale, Arizona 85253
Tel: (480) 948-9662
Fax: (480) 948-9556

Navaid Lighting Associates, Inc.
141 Autumn Glenn Road
Saville, Mississippi 38866
Tel: (662) 869-8655
Fax: (662) 869-0065

Constant current regulator, series circuit tests, power system tests and similar tests shall be completed prior to the actual photometric testing. Proper photometric output is dependent upon proper current and voltage applied at the fixture and sign. Photometric testing shall be performed at night with minimum interference with airport operations. Not more than 24 hours prior to starting the test, the Contractor shall clean all the light fixtures to assure that the system is ready for the photometric testing.

A list of equipment to be used for both the electrical and photometric testing shall be submitted by the photometric testing firm for approval by the RPR.

b. Electrical Testing Requirements: The test results shall be documented in a test report, with eight (8) copies submitted to the RPR. One copy shall be forwarded to the Engineer. The report shall include test results, general quality of installation in terms of photometric performance, identification of deficient lights, analysis to identify the cause of any deficient lights (e.g., fixture alignment, light fixture or specific primary circuit segment), and recommendation for correcting any deficiencies found. The test data shall be presented in the form of a log book with the first readings entered in the log book, and with provisions for entering future readings for each light. All circuits installed as a part of this project shall be tested.

The Contractor shall be responsible for correcting any deficient condition identified as a result of photometric testing at no additional cost to the Owner. Retesting shall be performed by the testing agency to verify that the deficient condition has been corrected. All testing and any necessary retests shall be performed at the sole expense of the contractor.

Circuits and Regulators

Airfield lighting circuit testing shall include the measurement of the following characteristics of the airfield lighting circuit including:

- (1) Input current to the regulator (I_{in}).
- (2) Input voltage to the regulator (V_{in}).
- (3) Output current from the regulator (I_{out}).
- (4) Output voltage from the regulator (V_{out}).
- (5) Total power (KVA).
- (6) Reactive power (KVAR)
- (7) Resistive power (KW).
- (8) Power Factor (PF)
- (9) Total harmonic distortion of current (THD Current).
- (10) Total harmonic distortion of voltage (THD Voltage).

Measurements shall be made at one intermediate operating step and at the highest operating step of the controlling regulator. The regulator output current and voltage shall be set using a true RMS meter for calibration prior to the start of circuit testing.

In addition, voltage wave forms of the circuits tested shall be obtained using an oscilloscope and recorded in an effort to identify any unusual circuit characteristics.

Lighting Fixtures and Signage

The testing shall be performed on the light fixtures detailed below:

All lighting and signage systems installed in this contract.

c. Photometric Testing Requirements. The photometric test equipment shall have an array of sensors capable of taking simultaneous readings along the horizontal axis of the light output (refer to FAA Advisory Circular (AC) 150/5345-46, latest edition). Photometric testing shall include the measurement at each light fixture of the light distribution along the horizontal axis. The measurements shall be compared with FAA standards presented in the AC for each type of light fixture. The highest sensor reading, together with the two adjacent readings, will be averaged, and the calculated average shall be at least 20% greater than the minimum average intensity specified in the AC or in the project specifications, whichever is greater, in order for that fixture to be considered acceptable. In addition, all other readings within the specified ellipse shall be at least 50 percent of the specified minimum average intensity in order for the fixture to be considered acceptable. Results shall also be compared with the requirements set forth in FAA AC 150/5345-46.

The software shall be capable of recording the data and analyzing that data to calculate:

- (1) The average photometric output of the main beam of the fixture,
- (2) The location of the maximum reading,
- (3) The location of the minimum reading,

- (4)** The ratio of the maximum reading to the average output,
- (5)** The ratio of the minimum reading to the average output, and
- (6)** Comparisons of these values with FAA specified values.

In every group of fixtures, that is, touchdown zone, centerline, or other such group, ten percent (10%) of the fixtures shall be evaluated at three (3) different vertical angles, on the centerline of the light beam, and at two (2) degrees above and below the centerline of the beam.

All sensor readings for the light fixture being evaluated shall be displayed simultaneously for operator and RPR review and evaluation. All sensor readings shall be recorded automatically through the computer and shall be printed out via a computer controlled printer. Hand written data will not be accepted.

For minimum impact on airport operations, the taking of photometric data at any one fixture shall be completed within thirty seconds.

d. Signs

(1) All new and modified signs shall be tested in accordance with specification 150/5345-44. The photometric testing of the guidance signs shall evaluate the performance of signs with respect to the following FAA criteria (reference FAA Advisory Circular 150/5345-44F):

(a) Luminance: The background of Type L-858Y signs and the legends of Type L-858R and L-858L signs shall have an average luminance of 10 to 30 ft lamberts.

(b) Uniformity: Photometric measurements shall be made on a 3 inch (76 mm) grid over the entire face of the sign, with no measurement being closer than 3 inches (76 mm) to the sign frame. Adjacent measurements shall not exceed a 1.5:1 ratio.

(c) The sign shall be discernable from eight hundred feet (800') away.

All new airfield guidance panels or signs installed on this project shall be tested at night. Style 2 and Style 3 signs shall be tested at each input current throughout the range on which the sign is to operate. Style 5 signs shall be tested at the highest rated input current (5.5 amperes).

(2) The photometric performance of the signs shall be evaluated using digital color images. These images shall be converted to gray-scale images that can be analyzed directly for photometric output. To provide calibration and control for the evaluation of the gray-scale image, direct photometric readings of the light output in foot-lamberts (FL) shall be taken at several locations on the face of the sign using a calibrated photometer. Light emitted only from the sign shall be permitted to reach the photometer.

To document compliance with FAA requirements, the Final Report (6 copies) shall present the following information and data for each color for each sign tested:

- (a)** Sign Designation & Date Sign was tested.
- (b)** Digital & Gray-Scale Image of Sign.
- (c)** Step - The step intensity of the regulator controlling the sign.

- (d) Arithmetic average of illumination levels (FL).
- (e) Maximum illumination level of sign face and/or message (FL).
- (f) Minimum illumination level of sign face and/or message (FL).
- (g) Ratio of Maximum illumination to Minimum illumination.
- (h) Uniformity. The maximum ratio of the average illumination levels of adjacent 3-inch areas over the face of the sign.
- (i) Visual Discernability of the Sign including comments.
- (j) Statements whether or not sign meets FAA criteria.

Photometric measurements shall also be taken of the red background on mandatory signs (white message on red background) to evaluate the signs red to white contrast. (FAA does not have criteria for contrast).

e. Test Reports. Interim reports will be submitted periodically during the progress of the work so that corrective measures may be taken as required by test results. If the corrective measures are made promptly, the circuits and fixtures involved will be retested during the scheduled period of field testing to assure that proper performance has been achieved. If the retesting cannot be done within this period, additional time and costs shall be borne by the Contractor.

The final test results shall be documented in a Final Report of which seven copies shall be submitted to the RPR. The Final Report shall document the field electrical and photometric testing and shall include the following:

(1) The electrical characteristics of each circuit and regulator tested, including a comparison with FAA requirements and with manufacturers' recommendations, as applicable.

(2) The photometric condition of each light fixture tested, as follows:

(a) Passes/Meets FAA Requirements - This classification includes those new light fixtures which exceed the FAA requirement, or, in the case of existing lighting systems, those fixtures which exceed 70 percent of FAA requirements. FAA specifies that airfield lights must be replaced when the outputs are less than 70 percent of the required output. In such cases, no further action is necessary other than periodic monitoring by the Owner. When nothing is indicated in the "Remarks" column of the photometric data, the light fixture is satisfactory.

(b) Fail/Investigate - These light fixtures have not met the FAA required photometric output for their particular type of light fixture. These fixtures shall be investigated by the Contractor to determine the cause of unacceptable performance. Appropriate corrective measures must be taken to bring the performance of the fixtures to FAA standards, and the fixtures shall then be retested to assure that the repairs/replacements are satisfactory. These light fixtures are indicated by an "F" in the "Remarks" column. Fixtures which are performing marginally, that is, producing outputs slightly below the specified limits, are identified with a "T" in the "Remarks" column which indicates that these units must be investigated to determine whether a simple cleaning or adjustment will bring the unit into compliance with FAA standards.

(3) Photometric test data tabulated with the following information:

fixture	Fixture Number	From the Identification sheets of the plans
	Light Direction	Direction of light beam
	Max CD	Maximum candela output in a point along the main beam
	Avg CD	Average candela output of the main beam
	Min Level (70%)	70 Percent of FAA specified output for type of
fixture	Lens Color	Color of lens on fixture being tested
	Con for 70%	Condition compared with 70 percent of FAA standard (blank if fixture is acceptable).
	Remarks	Notes pertaining to the fixture being tested.
	Corrective Action	Notes action taken to correct deficiency.

f. Spares. The Contractor shall furnish spare lamps, lenses, and fixtures for use in correcting any deficiencies at no additional cost to the contract.

g. Corrective Action. The Contractor shall be responsible for correcting any deficient condition identified as a result of the electrical and photometric testing. If satisfactory corrective actions cannot be completed within the originally scheduled test period, necessary additional site visits by the testing firm shall be at the Contractor's expense. The Contractor shall provide and install all materials, labor and all incidentals necessary for the required corrective action to bring the system or fixture into compliance with the Contract Documents.

h. There are no approved "repair" procedures for components that have failed testing other than complete replacement. Any other corrective measures shall be approved in writing by the RPR.

METHOD OF MEASUREMENT

111-4.1 The items described in this section are incidental to other sections and shall not be measured for payment.

BASIS OF PAYMENT

111-5.1 No direct payment shall be made for the work described in this section. The work described in this section is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

END OF ITEM L-111